

THE CALL TO



U.S. Marines wade ashore at Tinian in the South Pacific. The coastal processes research conducted at Scripps was widely applied to amphibious landings during World War II.



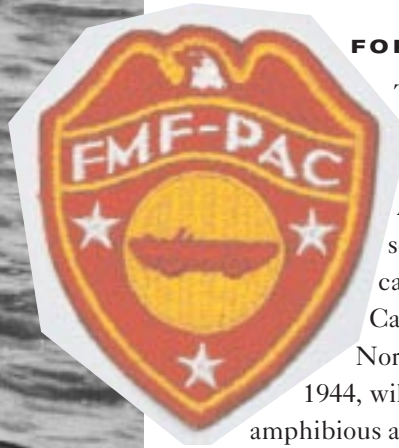
BY JOE HLEBICA



In 2003, Scripps Institution of Oceanography will celebrate its first century of oceanographic exploration, research, and discovery. This feature is the fourth in a continuing series of articles that will present special features about the history of Scripps Institution and the science, people, ideas, and technology that have played major roles in its century of leadership.



Scripps Institution of



FORECAST: VICTORY

There is a lull in the stormy weather battering the English Channel. Under overcast skies an armada of Allied ships plows through choppy seas. Soon, waves of landing craft carrying American, British, and Canadian troops will hit the beaches of Normandy and D-Day, the 6th of June, 1944, will be history. On this day, the largest amphibious assault ever mounted will end in victory for the Allies, marking a turning point in World War II. And in no small part, the success of this operation will count on efforts of a small team of oceanographers at Scripps.

HARALD ULRIK SVERDRUP

From 1941 to 1945, the Scripps Institution of Oceanography and its oceanographers were drawn into World War II military projects. Harald Ulrik Sverdrup, the wartime director of Scripps Institution, and Walter H. Munk, then a research assistant, devel-

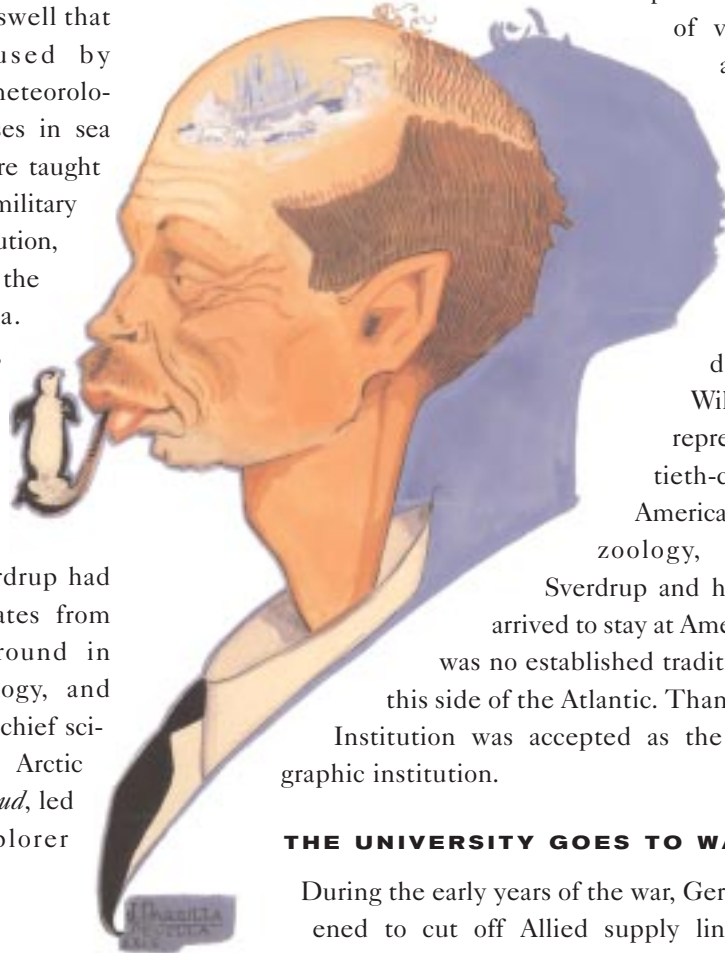
Harald U. Sverdrup,
below center, and
caricature, right.



oped a methodology for predicting waves, surf, and swell that was used by Allied meteorologists. Courses in sea forecasting were taught to more than 200 military officers at this institution, including John Crowell of the University of California. With Crowell's help, General Eisenhower and his commanders were able to interpret the data on sea conditions necessary to mount the Normandy invasion. Sverdrup had come to the United States from Norway with a background in oceanography, meteorology, and polar exploration. He was chief scientist on the 1917–1925 Arctic expedition aboard R/V *Maud*, led by the legendary explorer

Roald Amundsen. Sverdrup took over from Thomas Wayland Vaughan as director of Scripps in 1936.

Recognized as Scripps's first career oceanographer, Sverdrup was also known to be a witty man with tremendous energy. He was given to feats of physical prowess, including perfect handstands executed on parlor furniture to the delight of visiting scholars. Such antics must have come as a surprise to these scholars, considering he was one of the world's most respected marine scientists. The previous two directors, Vaughan and William Ritter before him, represented the early twentieth-century mainstream in American science—geology and zoology, respectively. Until Sverdrup and his European colleagues arrived to stay at American institutions, there was no established tradition of oceanography on this side of the Atlantic. Thanks to Sverdrup, Scripps Institution was accepted as the nation's first oceanographic institution.



THE UNIVERSITY GOES TO WAR

During the early years of the war, German submarines threatened to cut off Allied supply lines in the Atlantic. In





UCDWR personal (working at left and relaxing below) staffed laboratories on Point Loma, and at sea, contributing much to wartime research.



response, the National Defense Research Committee was established to mobilize all segments of American science in the interests of national security. As part of this effort, the University of California Division of War Research (UCDWR) laboratory was set up on Point Loma, California, near the Scripps campus.

Until 1942, Sverdrup supervised the scientific work of a small oceanographic division at UCDWR. Aboard research vessel *E. W. Scripps*, Scripps researchers tracked currents and water masses and developed instruments for calibrating micro-temperatures at sea. Using the newly developed and still classified bathythermograph, an instrument for measuring temperature as a function of depth, they worked to improve the capability of sonar to provide reliable imaging of under-



water targets.

A group of physicists including Carl Eckart, the institution's next director, and Russell Raitt, who would also become a research associate at Scripps's post-war Marine Physical

Laboratory, joined UCDWR. They investigated technical problems associated with antisubmarine warfare.

WALTER MUNK

In 1939, an Austrian-born graduate student named Walter Munk, studying applied physics at the California Institute of Technology (Caltech), sought a research opportunity at Scripps. At their first meeting, Sverdrup informed the young newcomer, "I can't think of any job in oceanography that will open in the next twenty years."

SCRIPPS INSTITUTION, THE U.S. NAVY, AND THE MARINE CORPS: A PERSONAL ACCOUNT

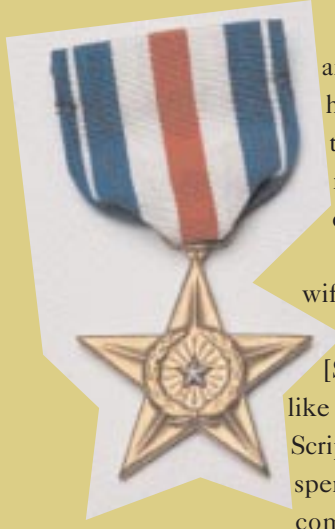
WALTER MUNK, A PROTÉGÉ of Norway's Harald Sverdrup at Scripps, was asked by the U. S. Navy in 1942 to study the problem of predicting surf conditions. This research was used to support Operation Torch, the Trans-Atlantic invasion of Vichy French North Africa planned for October of that year.

Munk began with the results of amphibious exercises in North Carolina and continued to develop some of the first systematic work that [the Navy] would call the science of coastal processes. The value of these inquiries to the U. S. Marine Corps is obvious. Marines paid with their blood in dodging the tides at Tarawa [in the South Pacific] for the gaps in our understanding of littoral processes. As science caught up with the corps' valor, Marines would not again vainly die crossing the surf zone.

Another team established by Roger Revelle of Scripps, and led by the extraordinary Mary Sears of Woods Hole Oceanographic Institution, worked out of the Navy's Hydrographic Office (HYDRO). HYDRO coordinated the collection of a vast quantity of oceanographic data, and analyzed it to produce methods that the U. S. Navy and Marine Corps used to their advantage tactically. Their work essentially set a new course—and a new name—for what today is the Naval Oceanographic Office. We have honored both Revelle and Sears by naming our most modern oceanographic ships after them.

Vice Admiral Paul Gaffney III

President, National Defense University; formerly Chief of Naval Research



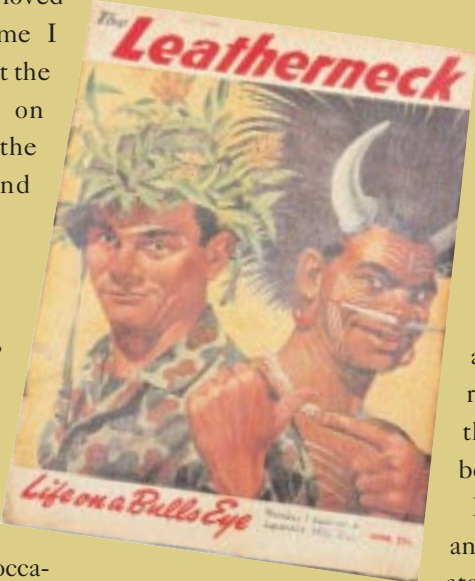
“I’ll take it!” was Munk’s ambitious reply. Sverdrup took him on as a student, and more than 60 years later, Munk is now professor emeritus of oceanography at Scripps.

Recalling Sverdrup, his wife, and the campus, Munk says, “Harald and Gudrun [Sverdrup’s wife] were like parents to me. I loved Scripps from the time I spent the first night at the community house, on the site now occupied by the Institute of Geophysics and Planetary Physics [IGPP].”

ROGER REVELLE

Upon enrolling at Scripps, Munk was soon befriended by Roger Revelle, who was then a research associate in oceanography. At the time, Munk was one of Scripps’s only students, and on social occasions Revelle would introduce him as “our

Trout fishing in America: Harald Sverdrup relaxing in the Sierras during his tenure at Scripps.



student body.” They became lifelong comrades.

Revelle had started at Scripps as a graduate student in 1931, receiving his Ph.D. in 1936. He took a leave of absence from the institution to spend the war years on active duty with the U. S. Navy. During his commission, he served both the nation and the interests of Scripps by establishing research contracts with Navy units including the Bureau of Ships, which eventually became the Office of Naval Research.

In 1946 Revelle was reunited with Munk and other oceanographers to test the effects of atomic bombs on U. S. Navy vessels at Bikini Atoll in the South Pacific and to determine the environmental impact of the explosions. This atomic testing was known as Operation Crossroads, and Revelle was soon appointed as the Navy’s chief oceanographer for that operation and for the Bikini Scientific Resurvey that followed.

Recognizing how Revelle’s naval expertise and oceanographic talents developed during the war, Sverdrup recommended him as future director at Scripps. As

Walter Munk (left), with mentor Harald Sverdrup, was a Scripps graduate at the end of World War II.



director, Revelle figured prominently in the institution's post-war expansion and later in the establishment of UC San Diego.



WAVES AND THE WAR

In *A Celebration in Geophysics & Oceanography—1982*, Munk writes, “In 1942, Sverdrup and I were told of the Allied preparations for an amphibious winter landing on the northwest coast of Africa. The coast is subject to a heavy northwesterly swell, with breakers exceeding six feet (2 meters) on two out of three days during winter. Yet practice landings in the Carolinas were suspended whenever the breakers there exceeded this height because of broaching of the landing craft. The problem, simply put, was to pick the one out of three days when the waves were suitable for landing.”



Munk and Sverdrup's answer was to develop a step-by-step process for reliably predicting waves on the basis of meteorological data.

“We scrounged together observations from oceans, lakes, and wave tanks and came out with rather pleasing results,” Munk recalls.

Their methods for predicting sea, swell, and surf were taught to classes of U. S. Navy and Army Air Force meteorologists, and were widely applied to amphibious landings in the Pacific and Atlantic theaters of war.

PINGING SUBS, SNAPPING SHRIMP, AND WATERPROOF HANDKERCHIEFS

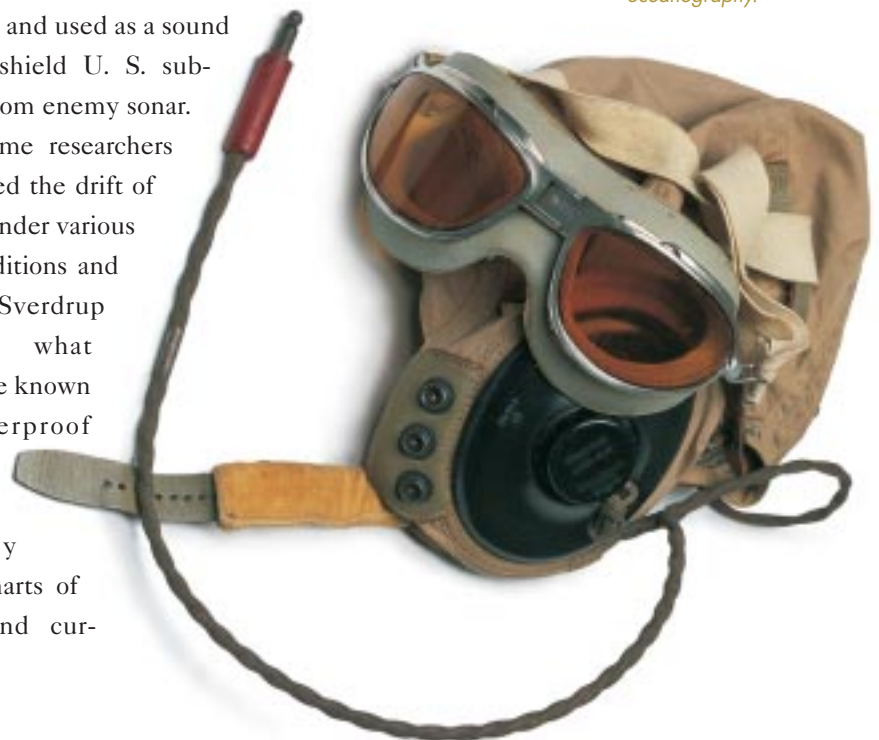
During the war, Scripps oceanographers helped develop high-frequency underwater sound systems to track submarines and detect mines. While working on these sonar systems, they also identified the anomalous crackling interference caused by aggregations of a large-clawed crustacean known as the snapping shrimp. Once analyzed, the noise produced by the shrimps' snapping claws was mimicked and used as a sound cover to shield U. S. submarines from enemy sonar.

Wartime researchers also studied the drift of life rafts under various wind conditions and currents. Sverdrup designed what came to be known as “waterproof handkerchiefs”—actually marine charts of islands and cur-



Above left, the first dedicated aquarium facility on the Scripps campus opened in 1915 and served the public until 1950.

Above, the bathythermograph, an early “secret weapon” of oceanography.






THE SCRIPPS LEGACY CONTINUES

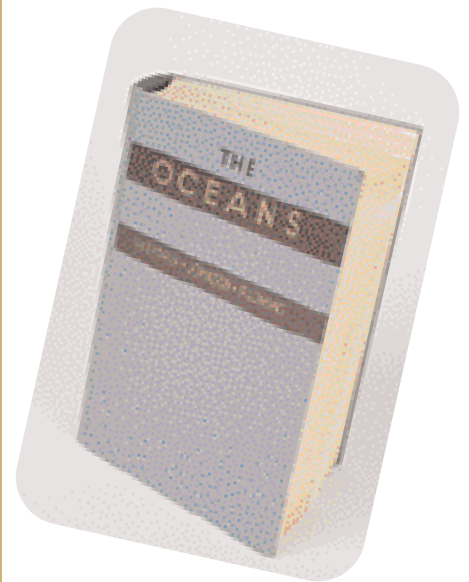
THE GREAT DEPRESSION had been especially difficult for science, and the institution might have closed were it not for the generosity of Robert Paine Scripps, son of founding benefactor E. W. Scripps.

The University of California had incorporated the institution into its campus in 1912, when much of its financial support was provided by the Scripps family. By 1925, UC was providing half the institution's funding with an agreement that the Scripps family would match these funds. When the depression hit in 1929 and government funding for education faltered, Robert P. Scripps forced the university's hand by quadrupling his family's yearly contributions. The university was obliged to match his ante of \$20,000. This shrewd maneuver probably saved Scripps from oblivion.

In 1937, following the loss of the institution's one research vessel to an explosion and fire, Sverdrup discussed the institution's need for a replacement vessel with Robert P. Scripps. He agreed to purchase a 104-foot schooner for the institution at a price of \$50,000. After the schooner was outfitted for research, Sverdrup renamed it R/V *E. W. Scripps* in honor of Robert's father. Taking the institution on its first long-range expeditions, *E. W. Scripps* sailed to-and-fro along the Southern California coast and well into the Gulf of California between the years 1938 and 1941. When war broke out, the ship was loaned to the U. S. Navy and operated by a new University of California research division in San Diego. 

Left, The schooner *E. W. Scripps* anchored north of the Scripps pier, in La Jolla Bay, circa 1940.

Below, *The Oceans: Their Physics, Chemistry, and General Biology* by Harald Sverdrup, Martin Johnson, and Richard Fleming. Published in 1942, it remained the definitive textbook of oceanography for many years.



rents printed on aviator's scarves and issued to flyers whose missions took them over water.

THE OCEANS


In 1942, Sverdrup, Martin Johnson, and Richard Fleming wrote *The Oceans: Their Physics, Chemistry, and General Biology*. At the time, it was the most comprehensive textbook of oceanography, “four pounds and all muscle,” according to one description. This text's authority is still respected to this day.



C. K. TSENG

**PIONEER PHYCOLOGIST,
RESEARCH DIVER,
AND SCRIPPS ALLY**

In 1944 Chinese postdoctoral fellow C. K. Tseng, a pioneer in the study of marine algae and aquaculture, performed some of the first underwater research at Scripps. Diving in unwieldy and dangerous “hard-hat” gear, he monitored seaweed growth in local waters. Tseng’s efforts were prompted in part by demand for agar, a seaweed by-product then vital to medical science. His direct observations presaged research diving activities that continue at Scripps to this day.

Following the war, Tseng returned to Qingdao where he helped found China’s first marine institute, based on Scripps and Woods Hole models. Although persecuted by the communists during the Cultural Revolution of the 1960s–1970s, Tseng remained a gallant supporter of Western scientific methods and a proud Scripps scholar. In 1999, at the age of 90, he personally honored Scripps director Charlie Kennel at Qingdao’s Institute of Oceanology, now celebrating its 50th anniversary. 

Below, Conceived at Scripps, silk flyer's scarves were printed with air/sea survival charts. A downed pilot could use this to find favorable currents and drift by life raft to safety.



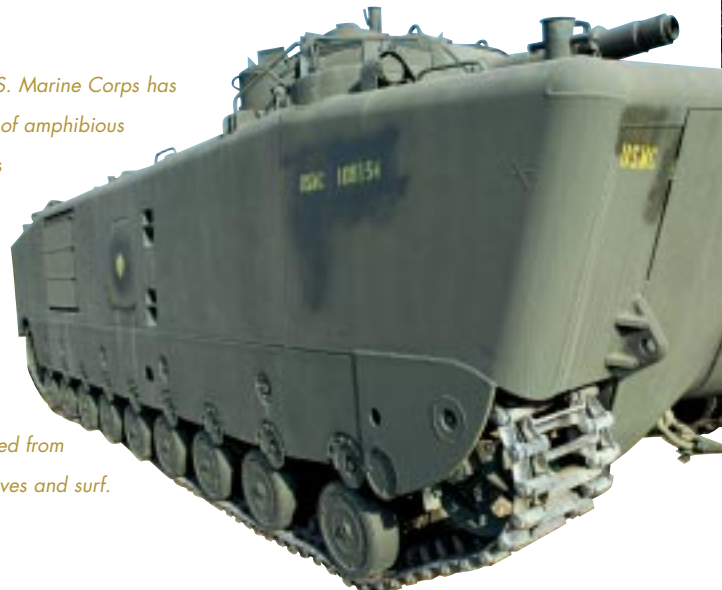
The 1,100-page book represented new research and a fresh perspective, and was so thorough that it was immediately classified by the U. S. government as a strategic document. The government also limited the sale of *The Oceans* to the United States and Canada the first year of its publication.

In 1948 Sverdrup returned home to head the Norwegian Polar Institute. Upon his departure from Scripps, the Navy awarded him its highest honor for a civilian, the Distinguished Public Service Award.

THE SVERDRUP CURRICULUM

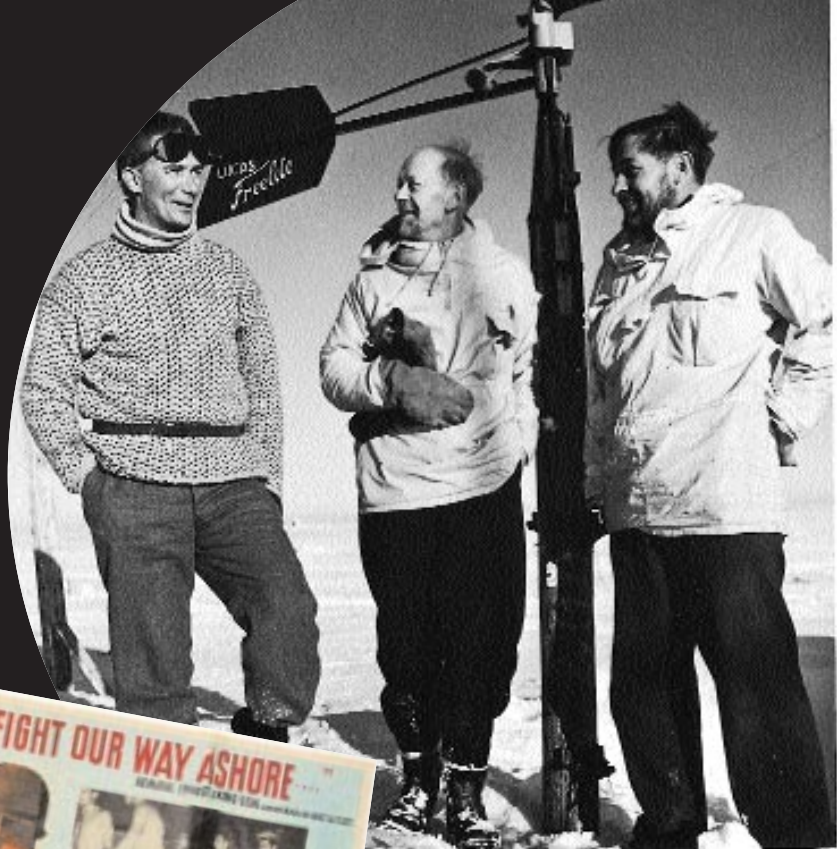
Professor emeritus Douglas Inman, founder of Scripps’s Center for Coastal Studies, was a Marine combat veteran and an entering graduate student at Caltech when he enrolled in the first organized graduate program in oceanography at Scripps in the fall of 1946. In a recent retrospective on the institution Inman writes, “Ritter’s beliefs in the interrelatedness of all

Right, The U. S. Marine Corps has used a number of amphibious tracked vehicles including this postwar model. Many have been designed with specifications based on principles derived from research on waves and surf.

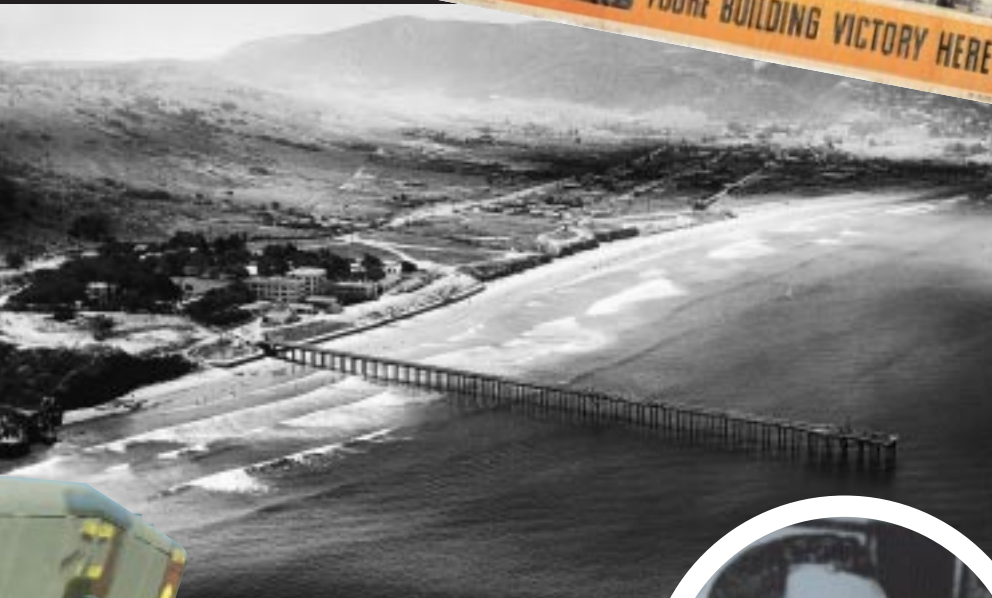


science and of science's obligation to enlighten society were extended and refined by Sverdrup. *The Oceans* charted the way, and the teaching curriculum at Scripps placed [the alumni] in daily action."

What came to be known as the "Sverdrup curriculum" required all entering students to take basic undergraduate courses in physical oceanography, marine chemistry, marine biology, marine geology, and mathematics before proceeding to graduate studies. Explains Inman, "This guaranteed the continuous growth and



Above, Harald Sverdrup, center, at the South Pole following his departure from Scripps. **Below,** Roger Revelle during Operation Crossroads.



Scripps campus circa 1940.



transfer of knowledge in the new science of oceanography. Graduates went forth and established Sverdrup-type interdisciplinary curricula throughout the world. This led to the rapid spread and development of oceanography as a science." 🌐